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Minimal Requirements for a Water Quality Assurance Program

Environmental Protection Agency, Washington, D C

Prepared for

Environmental Monitoring and Support Lab, Cincinnati, Ohio

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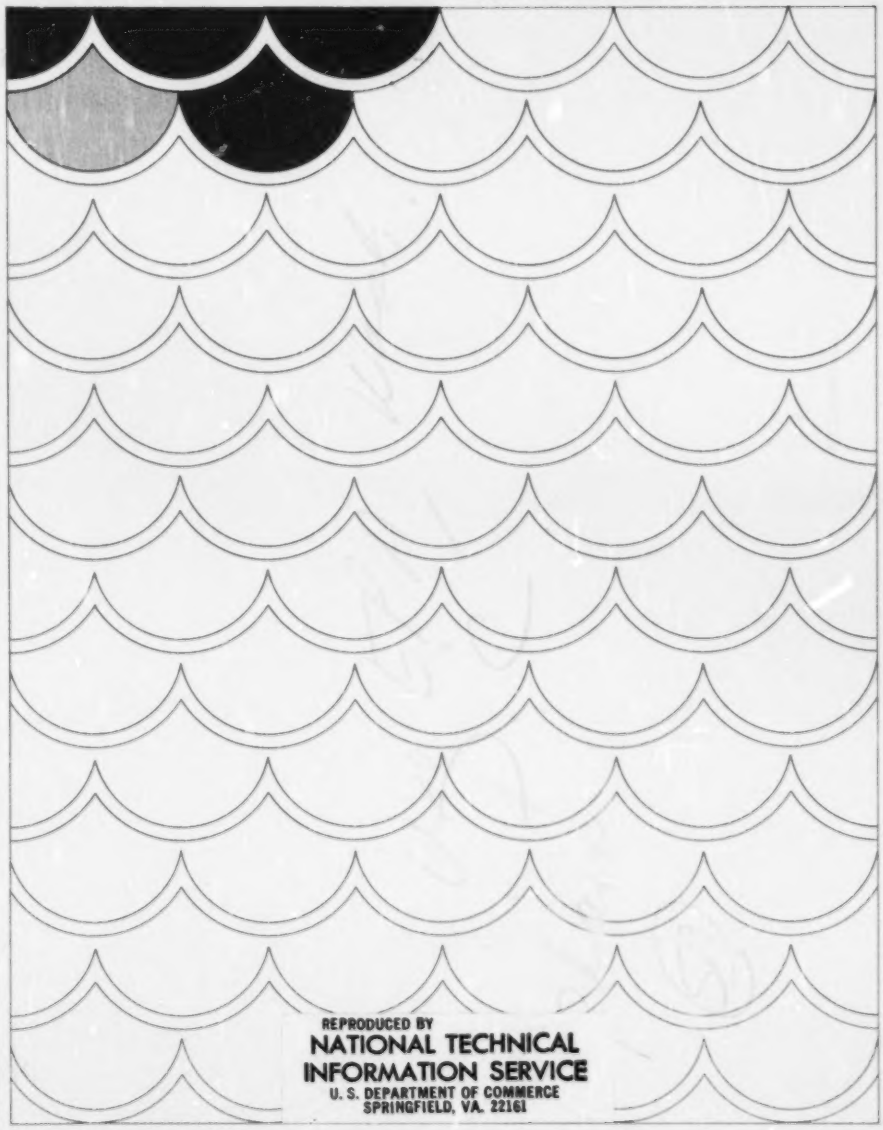

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Minimal Requirements for a Water Quality Assurance Program

U.S. Environmental Protection Agency
Office of Water Planning and Standards,
Monitoring and Data Support Division, and
Environmental Monitoring and Support
Laboratory, Cincinnati (EMSL-CIN, previously MDQARL)

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PART I
INTRODUCTION

A well planned water quality assurance program is essential to produce valid data. Quality assurance program planning is becoming increasingly more important as: A larger number of laboratories are producing analyses with resulting data; the equipment and procedures used for these analyses are increasing in variety and complexity; and there is an increasing need to consolidate data bases.

This document is a guide for planning and developing the necessary stages for implementing a successful quality assurance program, or improving an existing activity. It also outlines a typical Memorandum of Understanding (MOU). This memorandum is an agreement between the Environmental Protection Agency (EPA) regional office and the States on quality assurance procedures.

Since different geographical areas have different problems, this guidance document is intended to be flexible without being unduly specific. However, management should recognize that an effective quality assurance program can always be improved and that it requires constant attention.

This document consists of:

- An outline which describes a typical MOU;
- The overall requirements for a water laboratory quality assurance program, and;
- The basic elements that are an integral part of an on-going water quality assurance program. Some of these elements should be implemented immediately (PART IV); others should be implemented in the future (PART V).

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PART II

OUTLINE FOR A TYPICAL ANALYTICAL QUALITY ASSURANCE MEMORANDUM OF UNDERSTANDING

MEMORANDUM OF UNDERSTANDING BETWEEN (STATE) AND THE ENVIRONMENTAL PROTECTION AGENCY FOR ANALYTICAL QUALITY ASSURANCE

The following is a suggested outline for a typical Memorandum of Understanding.

Preamble

This agreement is entered into by (State) and the U.S. Environmental Protection Agency to ensure that monitoring programs specified under Public Law 92-500, The Federal Water Pollution Control Act, Amendments of 1972, will produce and document accurate and valid data.

Commitments

As an absolute minimal effort, this agreement commits approximately 10 percent of the monitoring program for quality assurance activities.

Specific water quality assurance techniques and procedures will be established for the following.

1. *Sampling and preservation.*
2. *Laboratory analysis.*
3. *Quality control:*
   a. *Determining precision;*
   b. *Determining accuracy;*
   c. *Evaluating daily performance; and*
   d. *Laboratory review.*
4. *Special Cases*
   a. *Instrumental field measurement.*
   b. *Unusual samples.*
   c. *Samples exceeding upper concentration limits.*
   d. *Procedures for application of alternative test procedures.*
5. *Specific Assignments and Documentation*
   a. *State Quality Control Officer.*
   b. *Documentation.*
6. *Reports.*

Term of Agreement

This agreement shall be signed by the Regional Administrator and the State Program Head and be effective from the date of signature.

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PART III
OVERALL REQUIREMENTS

DETERMINING COST/MANPOWER RATIOS

There should be a cost/manpower ratio of the resources allocated to quality assurance in ratio to the water monitoring budget to ensure that the necessary emphasis is placed on quality assurance.

In terms of management budgets, a cost ratio approximately 10 percent monies/manpower to total monitoring budget indicates there is a sufficient response to develop a minimal water quality assurance program. This is an average figure since resources will vary according to the stage of the program and to the program work schedule. In addition, it should be recognized that individual elements of the overall quality assurance effort will vary with time and with phases of the program, i.e., management, field sampling laboratory analysis, data handling, etc.

QUALITY ASSURANCE CONTROL COORDINATOR

Each State should designate a Quality Assurance Control Coordinator (preferably full-time) to be responsible for the entire water quality assurance program.

Qualifications

1. The coordinator should have as a minimum a bachelor's degree in chemistry, biology, or microbiology, with at least five years of experience in his respective discipline. In addition, coordinator must have actively worked in a water quality laboratory for at least two years. Experience in statistical quality control techniques and/or academic courses in mathematics and statistics is also highly desirable.
2. The coordinator maintains close liaison with the appropriate EPA Regional Analytical Quality Control Coordinator, and is responsible for the overall quality assurance program in his laboratory. The coordinator should report to the appropriate level: In no case should his function be subordinate to an individual responsible for direct conduct of sampling or analyses. While the overall program workload will determine whether this position is a full-time or part-time responsibility, it should, in most cases be full-time.

General Duties and Responsibilities

The coordinator is responsible for developing and implementing an inter-and-intralaboratory quality control program. Specific duties include, but are not necessarily limited to:

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1. Participating in the overall quality control plan. This includes all elements of the sampling and analytical programs. The coordinator carries out this activity within EPA quality control and methodology guidelines. Other recommended and accepted procedures can be used to supplement these guidelines.
2. Administering the interlaboratory quality control program as a continuing in-house activity to ensure the integrity and validity of analytical data.
3. Measuring the precision and/or accuracy of analytical results. Provides on-line quality control of samples, i.e., reference samples, duplicates, control charts, spiked, and audit samples.
4. Providing a permanent record of instrument and analyst performance as a basis for evaluating data.
5. Identifying training needs and technical methodology gaps.
6. Upgrading the overall quality of laboratory performance by recommending procedural and personnel changes, as required, to ensure the validity and integrity of the data.
7. Coordinating the inter-and-intralaboratory quality control program with the Environmental Monitoring and Support Laboratory - CIN (ESML-CIN), and other governmental and commercial laboratories. This involves participating in round-robin methodology studies, providing quality control check samples, and performance of check samples to requesting laboratories.
8. Evaluating and discussing the results of activities outlined in Paragraphs 1 through 7 with the appropriate individuals involved. When an analysis is out of control or a discrepancy is noted, the coordinator should be notified and appropriate corrective action should be taken.

ASSESSING PRESENT LEVEL OF OPERATION

Competence of Personnel

The coordinator should develop a training program to ensure a minimal level of proficiency. He must recognize variations in ability and provide training to ensure that professional skills are appropriate to the task. Training programs should be administered in order to develop that level of competence which is necessary to carry out assigned functions. Moreover, these

programs should be carried out in full cooperation with EPA regional analytical quality control coordinators.

Basic Facility and Equipment Requirements

The coordinator should establish basic requirements (equipment, proper facilities, etc.) for operating a water quality laboratory. These requirements should not be included as part of the quality assurance budget. Laboratory facilities should provide an environment free from atmospheric contaminant levels which can affect the desired analyses. The laboratory should be clean, air-conditioned and/or heated, and have a well lighted work area. Safety features and other facilities consistent with operational requirements should be provided.

Initial On-Site Laboratory Evaluation

The coordinator will implement his planned quality assurance program with an initial on-site laboratory evaluation. Subsequent performance of analysis on audit samples and participation in split sample program with the EPA regional office should also be required.

PART IV
BASIC ELEMENTS — TO BE IMPLEMENTED IMMEDIATELY

CALIBRATING SAMPLING EQUIPMENT AND FLOW MEASURING DEVICES

Sampling equipment and flow measuring devices should be calibrated according to manufacturer's specifications immediately before and after use in the field, or more frequently if necessary. Calibration and checks should be recorded permanently.

CALIBRATING DIRECT-READING FIELD INSTRUMENTS AND FIXED CONTINUOUS MONITORING DEVICES

1. Direct-reading field instruments should be calibrated according to manufacturer's specifications immediately before and after use in the field. In addition, spot checks should be made at reasonable intervals throughout the sampling schedule.
2. Fixed continuous monitoring devices should be calibrated according to manufacturer's specifications. Wherever possible, results will be verified by approved manual methodology. The calibration of sensors should be checked at least weekly, and preferably on a daily basis.
3. Calibrations and checks of both types of instruments should be recorded in logbooks or other permanent records.

REPRESENTATIVE SAMPLING

Assurance of representative sampling, both as to site selection and frequency requires a survey design which provides: 1) A sufficient number of sampling locations; 2) types of samples, and; 3) frequency of sampling. These will provide a valid representation of the characteristics being assessed, and should ensure that survey objectives are met.

Sampling techniques are covered in the following publications.

- Annual Book of ASTM Standards (Part 31), Water, American Society for Testing and Materials, Method D 3370 pp. 71-82, Philadelphia, Pa. July 1975.
- Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents, C.I. Weber, Ed., Methods Development and Quality Assurance Research Laboratory, NERC, USEPA Cincinnati, Ohio, July 1973.
- Handbook for Monitoring Industrial Wastewater, Technology Transfer, USEPA, 1973.

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- Standard Methods for the Examination of Water and Wastewater (13th Edition), APHA, AWWA, and WPCF, Washington, D.C., pp. 34-36, 1971.

COLLECTING AND PRESERVING SAMPLES

Required Documentation

Sample collection, handling, and preservation will be performed according to the following documents.

- Manual of Methods for Chemical Analysis of Water and Wastes, EPA-625/6-74-003, U.S. Environmental Protection Agency, Office of Technology Transfer, Washington, D.C., 20460, 1974.
- Standard Methods for the Examination of Water and Wastewater, Thirteenth Edition, American Public Health Association, 1975.
- Annual Book of ASTM Standards (Part 31), Water, American Society for Testing and Materials, Method D, 3370 pp. 71-82, Philadelphia, Pa. July 1975.
- Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents, EPA-670/4-73-001, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio, 45268, July 1973.

Additional methods and procedures may be used as approved or stipulated by the EPA Administrator or Regional Administrator.

Time-Sensitive Samples

Time-sensitive samples should be delivered from the field and analyzed within specified holding times. Until superseded by designations in published EPA analytical reference methods, maximum holding times for sensitive samples will be as specified in the EPA manuals identified in the previous paragraph.

Procedures

Procedures should be developed to ensure sample integrity during sampling, transport, storage and analysis.

LABORATORY ANALYSIS

Physical and Chemical Analysis

Physical and chemical analysis should be conducted using the analytical methods described in: Federal Register, Federal Water

Pollution Control Act of 1972 (86 Stat. 816 et. seq. Public Law 92-500 (1972). The Federal Register includes selected methods from the following documents.

- Standard Methods for the Examination of Water and Wastewater, Thirteenth Edition, American Public Health Association, 1971.
- Manual of Methods for Chemical Analysis of Water and Wastes, EPA-625/6-74-003, U.S. Environmental Protection Agency, Office of Technology Transfer, Washington, D.C., 20460, 1974.
- 1975 Annual Book of ASTM Standards Part 31, Water, July 1975.

Biological Analysis

Biological analysis should be conducted according to the following documents.

- Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents, EPA-670/4-73-001, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio, 45268, July 1973.
- Standard Methods for the Examination of Water and Wastewater, Thirteenth Edition, American Public Health Association, 1971.

Alternative Test Procedures

Alternative test procedures can be used provided that the stipulations in the Federal Register statement under "Physical and Chemical Analysis" and as set forth in State statutes and regulations have been satisfied. Analyses conducted on parameters not identified in regulations pursuant to Section 304 (g) Public Law 92-500, should be performed according to generally acceptable methods, unless otherwise specifically required by the regional administrator.

RECORDING, STORING, AND RETRIEVING DATA

Field and laboratory personnel should keep complete and permanent records to satisfy legal requirements for potential enforcement or judicial proceedings. The sampler should sign the field sheets, and the analyst should sign the laboratory data sheets. In addition, an information system should be developed which can prepare, screen, validate, sort, and make waterwaste monitoring data collected by the State available to EPA.

CHAIN-OF-CUSTODY

The following procedures have been used successfully, and are presented as suggested procedures insofar as they fulfill the legal requirements of the appropriate State legal authority.

Procedures

Quality assurance should be stressed during all compliance monitoring and when reviewing self-monitoring programs, no matter what the reason for the spot check or inspection. Successful implementation of a compliance monitoring program depends heavily on the capability to produce valid data, and on clearly demonstrating such validity. No other environmental monitoring area requires more rigorous adherence to validated methodology and quality control measures.

It is imperative that laboratories and field operations involved in collecting primary evidence prepare written procedures. These procedures should be used whenever evidence samples are collected, transferred, stored, analyzed, or destroyed. A primary objective of these procedures is to create an accurate written record which can be used to trace possession of the sample from the time it is collected through its introduction into evidence.

Preparing Samples

The evidence-gathering portion of a survey is characterized by an absolute minimum number of samples required to give a fair representation of the effluent or water body sampled. The quantity and location of samples are determined before the survey.

Prepare chain-of-custody record tags before actual field survey work. Ensure tags contain all possible information to minimize clerical work by field personnel. Also write the source of each sample on the container before starting any field survey work.

Field logsheets used to document field procedures and chain-of-custody, and to identify samples, should be pre-filled to the extent practicable to reduce repetitive clerical field entries. The sampler or project leader should maintain custody during sampling, using the logbook. Any information from previous studies should be copied (or removed) and filed before the logbook is returned to the field.

Follow explicit chain-of-custody procedures to maintain the documentation necessary to trace sample possession from the time the sample is taken until the evidence is introduced into court. A sample is in your custody if:

- It is in your physical possession; or
- It is in your view, after being in your physical possession; or
- It was in your physical possession and you locked it in a transfer-proof container or storage area.

All survey participants should receive a copy of the study plan and should be familiar with its contents before the survey begins. A pre-survey briefing should be held to inform all participants of the survey objectives, sample locations and chain-of-custody procedures. After all chain-of-custody samples are collected, a debriefing should be held in the field to verify that chain-of-custody procedures have been followed, and to determine if additional evidence samples are required.

Collecting Samples

1. Ensure that the smallest possible number of people handle the sample.
2. Obtain stream and effluent samples using standard field sampling techniques. When using sampling equipment, assume it is in the custody of the source being sampled.
3. Attach chain-of-custody record tag to the sample container when the complete sample is collected. Ensure the container has the following information: sample number, time taken, date taken, source of sample (include type of sample and name of firm), preservative, analyses required, name of person taking sample, and witnesses. The front side of the card (which has been prefilled) is signed, timed, and dated by the person doing the sampling. Tags must be legible and filled out in ballpoint (water-proof ink). Secure individual sample containers or group of sample containers using a tamper-proof seal.
4. Take blank samples. Include one sample container without preservative, and containers with preservatives. The laboratory will analyze these contents to verify if any containers are contaminated.
5. Maintain an up-to-date Field Data Record Logbook. Record field measurements and other pertinent information necessary to refresh the sampler's memory if, later on, he takes the stand to testify regarding his actions during the evidence-gathering activity. Maintain a separate set of field notebooks for each survey; store them in a safe place where they can be protected and accounted for at all times.

Standard formats have been established to minimize field entries; these include the date, time, survey, type of sample taken, volume of each sample, type of analysis, sample number, preservatives, sample location and field measurements (temperature, conductivity, DO, pH, flow), and any other pertinent information or observations.

The field sampler signs the entries. The survey coordinator is usually responsible for preparing and conserving the field logbook during the survey. Once the survey is complete, field logs will be retained by the survey coordinator or his designated representative, as a part of the permanent record.

6. The field sampler is responsible for the care and custody of the collected samples until they are properly dispatched to the receiving laboratory, or turned over to an assigned custodian. The field sampler should verify that each container is in his physical possession or in his sight at all times, or is locked so that no one can tamper with it.
7. Colored slides or photographs are often taken to show the outfall sample location and any visible water pollution. Written documentation on the back of the photo should include the photographer's signature, and the time, date, and site location. These photographs can be used as evidence, and are handled by chain-of-custody procedures to prevent alteration.

Transfer of Custody and Shipment

1. When transferring the possession of samples, the transferee signs, dates, and times the reverse side of the chain-of-custody record tag or record. Custody transfers, if made to a sample custodian in the field, are made for individual samples. The chain-of-custody tag or card must be dated and signed by the second person who takes custody. If a third person takes custody, he must follow the same procedure. An additional chain-of-custody tag or card is completed by persons who thereafter, take custody. It is apparent, from this chain, that the number of custodians should be minimal. Additional tags or cards should be numbered consecutively.
2. If a custodian has not been assigned, the field custodian or field sampler is usually responsible for properly packaging and dispatching samples to the proper laboratory for

analysis. In that case, the "Dispatch of Sample" portion of the chain-of-custody record tag or card should be properly filled out, dated, and signed.

3. Ensure that samples are properly packed in shipping containers (for example, ice chests) to avoid breakage. Ensure that shipping containers are padlocked for shipment to the receiving laboratory.
4. Include a "Sample Transmittal Sheet" with all packages. The original, and one copy generally accompany the shipment. Mail copies directly to the laboratory, to data management personnel, and to any other responsible agent. The survey coordinator usually retains one copy.
5. If the package is sent by mail, ensure that it is registered with return receipt requested. If package is hand-delivered, record delivery in the logbook. Send receipts from post offices and bills of lading to the laboratory custodians for retention as part of the permanent chain-of-custody documentation.
6. When samples are delivered to the laboratory, and appropriate personnel are not there to receive them, samples should be locked in a secure, tamper-proof area. The same person must unlock the samples and deliver custody to the appropriate custodian.

Laboratory Custody Procedures

The following procedures are recommended by the EPA's National Enforcement Investigation Center, and are suggested to the State insofar as they comply with the State's statutory and regulatory requirements.

1. The laboratory director will designate one full-time employee (usually the laboratory supervisor) as a sample custodian, and one other person as an alternate. In addition, the laboratory must provide a sample storage area that is secure. This is a clean, dry, isolated room which can be securely locked.
2. All samples will be handled by a minimum possible number of persons.
3. Only the custodian will receive incoming samples. If he is absent, the alternate will indicate receipt by signing the sample transmittal sheets and, (as appropriate), the sample tags which accompany the samples. The alternate will retain the transmittal sheets as permanent records.

PART V
BASIC ELEMENTS — TO BE IMPLEMENTED IN THE FUTURE

NOTE

Refer to Handbook for Analytical Quality Control in Water and Wastewater Laboratories, MDQARL, NERC, USEPA, Cincinnati, Ohio, June, 1972.

ESTABLISHING PRECISION AND ACCURACY OF METHODS

This important step must be accomplished before proceeding to the tests and studies in the following paragraphs. However, as one parameter is tested and its testing methods are checked for precision and accuracy, the test procedures which follow can be started for that parameter. After a six-to-twelve month period, all methods used in the laboratory should have been tested for precision and accuracy, and the following tests and studies begun.

According to the handbook cited above, actual samples, not standards, should be used to determine the precision and accuracy of the methods. The resulting data should be compared with published interlaboratory precision/accuracy data to determine that the analyses are in control. Once these data are documented, the procedural steps which follow should be practiced on a routine basis. Check the handbook for specific details.

QUALITY CONTROL CHECK SAMPLES (REFERENCE SAMPLES)

These samples are provided as a technical service free of charge to the requestor, and can be obtained through the appropriate EPA regional analytical quality control coordinator. Do not use them on a daily basis; rather, use them as an independent check on the entire system approximately every three to six months. The samples were prepared as sterile concentrate and are in sealed vials. Constituents available include mineral series, nutrient demand, trace metal series, mercury, LAS, chlorophyll, and others to be announced.

INTRA-AND-INTER-LABORATORY STUDIES

The following studies are for laboratory performance and methods validation. They should be included in the overall quality assurance effort, and the results documented to ensure that data are valid.

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Methods Validation Studies

The laboratory should participate in round-robin studies conducted according to official programs to determine the interlaboratory precision and accuracy of methods.

Audit Sampling Programs

The laboratory should participate in the use of split, blind performance check samples, and other audit-type samples that are prepared either on an intra or inter-laboratory basis. The resulting comparative data should compare favorably with the established precision and accuracy data of the respective measurements.

DAY-TO-DAY ACTIVITIES

The normal day-to-day working routine should require:

1. That duplicate samples be run approximately 10 to 20 percent of the time to verify the reproducibility of the respective methods. Data should compare favorably with initially-established precision data.
2. That known amounts of standard material be added to samples on a 1:1 concentration basis to verify the ability of the method to measure the particular constituent under consideration. Again, approximately 10 to 20 percent of the time should be spent on this activity. The resulting data should compare favorably with the initially-established accuracy data.
3. That some systematic, documented method for recording quality assurance data be in routine use. The method should be prepared so that it is available for future reference and can be readily understood and interpreted by all concerned.

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